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Description

[APPARATUS FOR HARVESTING ENERGY FROM MOVING FLUIDS]

BACKGROUND OF INVENTION

[0001] The invention relates to apparatus for harvesting energy from moving fluids including but not limited to air currents, winds, rivers and tidal water. Substantial effort has been expended in the search for more efficiently harvesting naturally occurring energy.

[0002] For many applications, but not all applications, it is desirable to provide apparatus in accordance with the present invention in which a rotor is mounted on a vertical axis. The prior art includes a variety of vertical axis rotating machining. Examples include the Articulated Blade with Automatic Pitch and Camber Control described in United States Patent 5,193,978 issued to Bill Guitierrez on March 16, 1993. This patent describes a structure that is relatively complex control to control a flap. United States patent 3,877,836 entitled Horizontal Windmill issued to Leo L. Tompkins on April 15, 1975. The structure described therein does not show her suggest the more efficient apparatus in accordance with the present invention.

SUMMARY OF INVENTION

[0003] It is an object of the present invention to provide a simple structure to

harvest energy from moving fluids.

[0004] It is another object to the present invention to provide a higher efficiency than previously known apparatus.

[0005] Another object of the present invention is to provide an apparatus that is relatively simple and capable of manufacture easily and inexpensively to wide utilization throughout the world.

[0006] It has now been found in the object of the invention may be attained in apparatus for harvesting energy from a fluid stream which includes a rotor comprising a plurality of generally planar frames radiating from a common geometric axis. The common geometric axis is coplanar with each of the plurality of generally planar frames; each of the generally planar frames having first and second opposed edges, each of the first opposed edges each being disposed proximate to the common geometric axis, each of the second opposed edges of the frames are disposed in distal relationship to the common geometric axis. Each of the first and second generally planar frames have an opening therein. The apparatus further includes a plurality of generally planar flappers, each of the generally planar flappers has first and second opposed edges, each of the first edges of each of the plurality of flappers is mounted by hinges to the second edge of one of said plurality of frames, each of the generally planar flappers has a part thereof that overlaps at least a part of the frame to which it is mounted when the flapper is disposed in substantially face to face abutting relationship to the frame on which it is mounted so that said flapper will not pass

through said opening.

[0007] In some forms of the apparatus in accordance with the present invention each flapper overlaps the frame to which it is mounted along at least two sides thereof when the flapper is disposed in face to face abutting relationship to the frame on which it is mounted. In other forms of the present invention and each flapper overlaps the frame to which it is mounted along at least four sides thereof when the flapper is disposed in face to face abutting relationship to the frame on which it is mounted.

[0008] Each of the frames may have a first area defined by the periphery of the frame and each of the openings in each of the frames has a second area defined by the opening and the second area is a substantial part of the first area. In some cases the second area is at least 90 percent the first area.

[0009] In some embodiments of the invention the rotor includes a sleeve having an axis substantially coincident with a common geometric axis and the sleeve is dimensioned for mounting on an associated shaft. In other embodiments of the invention the rotor includes a shaft having an axis substantially coincident with the common geometric axis and the apparatus includes bearings supporting the shaft.

[0010]

In some embodiments of the apparatus each part of each of the frames has a dimension in the direction of movement thereof that is smaller than each part of each of the frames in a direction perpendicular to the

direction of movement. Each of the frames may be manufactured of a reinforced composite material.

BRIEF DESCRIPTION OF DRAWINGS

[0011] The invention will be better understood by reference to the accompanying drawing in which:

[0012]

[0013] Figure 1 is a simplified diagrammatic side elevation view of a portion of the apparatus in accordance with one form of the invention including a mounting column and frames that extend radially from the mounting column.

[0014] Figure 2 is a top diagrammatic plan view of the structure shown in Figure 1.

[0015] Figure 3 is a top diagrammatic plan view of the entire apparatus that includes the apparatus shown in Figures 1 and 2 and also illustrating the pivotal mounting of flappers at the free extremities (the extremity of the frames remote from the mounting column) of the respective frames.

[0016] Figure 4 is a top diagrammatic plan view of the apparatus shown in Figure 3 illustrating the positions of the respective flappers in one instantaneous position in the operating cycle thereof in the presence of a prevailing wind in the direction indicated by the arrow A.

[0017]

Figure 5 is a fragmentary top diagrammatic view illustrating an embodiment of the invention in which a column carries the radially

extending supports.

[0018] Figure 6 is a fragmentary top diagrammatic view illustrating an embodiment of the invention in which a cylindrical sleeve carries the really extending supports and the sleeve is dimensioned and configured for receiving a column within the sleeve. The sleeve is structured to permit rotation of the sleeve around the column.

[0019] Figure 7 is a diagrammatic view of an alternate geometric relationship between a flapper and a boom on which the flapper is mounted.

[0020] Figure 8 is a diagrammatic sectional view taken along a horizontal plane (designated by the letters 8-8 in Figure 1) extending intermediate the top and bottom of the frames.

[0021] Figure 9 is a diagrammatic view of an alternate geometric relationship between a flapper and a frame in which the flapper has a height that is greater than the height of the frame.

DETAILED DESCRIPTION

[0022]

[0023] Referring now to Figures 1-6 there is an apparatus 10 for harvesting energy from a moving fluid. In the embodiment illustrated in Figures 1-5 the apparatus 10 includes a general cylindrical shaft or column 12 which supports the rest of the apparatus 10 for rotation. The column 12 is mounted by suitable bearings 13 to allow rotational movement of the apparatus 10.

[0024] In the preferred embodiment four radially extending frames 14, 16, 18, and 20 extend from the column 12 at 90 degree intervals. As best seen in Figure 1 frames 14, 16, 18 and 20 are preferably designed to having minimum weight and a minimum fluid drag while retaining sufficient rigidity to provide support during the operating cycle. Each frame 14, 16, 18, and 20 has a first side fixed to the column 12. First sides 14a and 18a are visible in Figure 1. First sides 14a, 16a, 18a and 20a are visible in Figure 2. Each frame 14, 16, 18 and 20 has a second or free side identified respectively by reference numerals 14b, 16b, 18b and 20b.

[0025] As best seen in Figure 3 a hinge 22 is carried on each of the free ends 14b, 16b, 18b and 20b. Each hinge 22 supports a flapper 24. Each flapper 24 is an imperforate generally planar body dimensioned and configured to overlap at least a part of one of the frames 14, 16, 18 or 20 to which it is attached. In the preferred embodiment each flapper 24 (when folded over the frame to which it is mounted) will overlap the frame on which it is mounted on all four sides of the frame. In other embodiments only some part of the flapper (when folded over the frame to which it is mounted) will overlap some part of the frame. Some overlap of some part of the flapper with respect to the frame is necessary to prevent the flapper from passing through the opening in the frame.

[0026] As best seen in Figure 4 there is shown a diagrammatic representation of one position of the apparatus 10 including the flappers 24 in the

presence of a prevailing wind in the direction indicated by the Arrow A. For ease of description the various positions of the flappers 24 will be described in terms of a clock face having the center thereof at the hinge pin of the hinge connecting the frame and the flapper. With (1) the flapper 24 carried by the frame 14 at the 3 o"clock position and folded across the face (with respect to the prevailing wind) of frame 14 and (2) the flapper 24 carried by the frame 18 at the 12 o"clock position folded away from the frame 18 a clockwise movement of the apparatus 10 will occur because the force produced by the prevailing wind or other fluid flow A will all be on the left side (as viewed) of the apparatus 10. Accordingly, the apparatus will start to rotate in a clockwise (as viewed in Figure 4) direction.

[0027] As illustrated by the flapper 24 on the frame 16 the flapper 24 has moved to the 12 o"clock position and extends in a generally radial direction away from the column 12 as shown in Figure 4 as the result of fluid and centrifugal forces. Those skilled in the art will recognize that once rotation is started in a clockwise direction that direction of movement will continue as long as the prevailing wind (or other fluid stream) continues. Furthermore, even if the prevailing wind or other fluid stream were to stop for a given interval the position of the flappers 24 at the time the fluid stream stopped will insure rotation in the same direction when the movement of the fluid stream resumes.

[0028] The illustrated flapper 24 mounted on the frame 18 is still at the 12 o"clock position, however there is now a 90 degree angle between the

frame 18 and the flapper 24 to which it is mounted.

[0029] As illustrated by the flapper 24 mounted on the frame 20 the flapper 24 hinged to the frame 18 is still at the 12 o"clock position however it is now folded into face to face abutting relationship with the frame 20.

[0030] As illustrated by the flapper 24 carried by the frame 14, upon a further 90 degree clockwise movement of the apparatus 10 the flapper 24 hinged to the frame 18 will remain in the same relative position (face to face abutting) with respect to the frame 18 as best seen in Figure 4.

[0031] The description of the sequential positions of the apparatus and the flappers 24 will be understood to be based on the assumption that the flapper 24 mounted on the frames 14 is folded to the position shown in Figure 4. Those skilled in the art will recognize that if the flapper 24 mounted on the frame 18 is folded across the face (the side of the frame 18 facing the prevailing wind A) and the flapper 24 mounted on the frames 14 is initially trailing behind (with respect to the prevailing wind A) at right angles to the frames 14 the rotation will start and continue in a counterclockwise direction (as viewed in Figure 4).

[0032]

The frames 14, 16, 18 and 20 are identical in the preferred embodiment. The use of different reference numerals to identify the respective frames merely facilitates a clearer description of the apparatus. From an aerodynamic standpoint it is preferable that the frames 14, 16, 18 and 20 have a cross-section that is minimized in the direction of movement. For one such application of this principle is

illustrated in Figure 7. The diagrammatic view of Figure 7 illustrates a cross-section of a portion of the respective frames and specifically illustrates the design approach of providing a smaller dimension in the direction of movement. The cross-section view of Figure 8 illustrates the cross-section of the horizontal portions of the preferred form of respective frames in a cross-section view taken along the line 8-8 of Figure 1. It will thus be seen that the horizontal parts of the respective frames also have a cross-section that is minimized and the direction of movement. Accordingly, the aerodynamic resistance to movement is minimized.

[0033] Figures 5 and 6 illustrate respectively (1) portions of the embodiment illustrated in Figures 1-4 in which the frames 14, 16, 18, and 20 are mounted directly on a column 12 and (2) another embodiment in which the frames 14, 16, 18, and 20 are fixed to a sleeve 32 that revolves freely about fixed column 34. Those skilled in the art will recognize the equivalence of one structure to the other.

[0034] The cross-sections of the respective parts of the frames are preferably constructed with a minimum size consistent with the necessary rigidity and strength necessary to function. The cross-sectional shape is one facet of this design criterion. The use of lightweight and strong materials is preferable. Fiberglass reinforced composite materials are particularly attractive materials.

[0035] The illustrated embodiment has four frames 14, 16, 18, and 20. Other embodiments may have more or less radially extending frames that are

each provided with cooperating flappers 24. A limitation on the number of frames that radiate from a common axis is the clearance required for movement of the respective flappers 24. Ordinarily the number of frames radiating from the common axis will be an even number. In some embodiments the height of the frame and the cooperating flapper may be much greater than the width thereof. In some embodiments the height of the cooperating flapper may be greater than the frame to which it is mounted by hinges. Figure 9 illustrates a fragment of an embodiment in which a flapper 124 has a relatively greater height than width in addition to having a height that is greater than the height of the frame 118. Such a geometric relationship does not cause any interference with the adjacent frame and yet permits the harvesting of additional energy because the surface area is much greater. Figure 10 illustrates a fragment of still another embodiment of the invention in which a flapper 124 is mounted on an elongated boom 218. Such an embodiment minimizes the drag and weight of the rotating structure. Although some embodiments may have conventional hinges securing the flapper to a frame or boom it will be understood that some embodiments may utilized merely a flexible piece of material joining the flapper and the frame or boom.

[0036]

Although the apparatus disclosed herein has been described with respect to certain materials and construction, it will be obvious to those skilled in the art to make various changes from the illustrated preferred embodiment. Such changes are considered to be within the spirit and

scope of the invention.

[0037]